F. GEOLOGY AND SOILS

SETTING

STATEWIDE GEOLOGIC HAZARDS

The geology in the project area can vary from upland areas underlain by bedrock to alluvial flatlands. Because of this varied geology, geologic hazards that could affect the proposed project include slope instability (landsliding) and settlement.

Settlement

Loose, soft soil material comprised of sand, silt and clay, if not properly engineered, has the potential to settle after a building is placed on the surface. Settlement of the loose soils generally occurs slowly but over time can amount to more than most structures can tolerate. Building settlement could lead to structural damage such as cracked foundations, misaligned or cracked walls and windows. Settlement problems are site-specific and can generally be remedied through standard engineering applications.

Landslides

Generally, a slope can fail when its ability to resist movement decreases and the stresses on a slope increase. The material in the slope and external processes such as climate, topography slope geometry, and human activity can render a slope unstable and eventually initiate slope movements and failures. Factors that decrease resistance to movement in a slope includes pore water pressure, material changes, and structure. Changes in slope material such as improperly engineered fill slopes can alter water movement and lead to chemical and physical changes within the slope.

STATEWIDE SOIL HAZARDS

Expansive Soils

Expansive soils possess a “shrink-swell” behavior. Shrink-swell is the cyclic change in volume (expansion and contraction) that occurs in fine-grained clay sediments from the process of wetting and drying. Structural damage may result over a long period of time, usually the result of inadequate soil and foundation engineering or the placement of structures directly on expansive soils. Typically, soils that exhibit expansive characteristics comprise the upper five feet of the surface. The effects of expansive soils could damage foundations of aboveground structures, paved roads and streets, and concrete slabs. Expansion and contraction of soils, depending on the season and the amount of surface water infiltration, could exert enough pressure on structures to result in cracking, settlement, and uplift.

Soil Erosion

Soil erosion is also a natural on-going process that transports, erodes and displaces soil particles through a transport mechanism such as flowing water or wind. Erosion is the physical detachment and movement of soil materials through natural processes or human activities. Depending on the local landscape and climatic conditions, erosion may be very slow to very rapid. The detachment of soil particles can be initiated through the suspension of material in either hydraulic (water) or aeolian (wind) setting.

Rates of erosion can vary depending on the soil material and structure, placement and human activity. The erosion potential for soils in the project is variable throughout the project area. Soils containing high amounts of silt can be easily eroded while sandy soils are less susceptible. Excessive soil erosion can lead to damage of building foundations, roadways, dam embankments and increased sedimentation to drainage ways.

The effects of excessive erosion range from nuisance problems that require additional maintenance, such as increased siltation in storm drains, to extreme cases where water courses are down cut and gullies develop, which can eventually undermine adjacent structures or vegetation. Human activities that disturb soils in arid regions increase wind erosion potential. The project area includes numerous landscapes from inland desert environments, coastal bluffs, alluvial plains, to steep ridgelines. For this reason, and in conjunction with the proposed project activities, the erosion hazard may be considered a potentially significant issue that is further addressed in the impact analysis.

SEISMICITY

The project area is located in a region that has historically experienced high seismicity. In the past 100 years, several earthquakes of magnitude 5.0 or larger have been reported on the active San Andreas, San Jacinto, Elsinore, Garlock, and Newport-Inglewood fault systems, all of which traverse the service regions. As a result, earthquake hazards have occurred in the region. Injury to people and damage to structures during earthquakes can be caused by actual surface rupture along an active fault, by ground shaking from a nearby or distant fault, liquefaction, or dam failure. Project facilities could be affected by shaking during seismic events on faults.

Faults

A fault is a fracture in the crust of the earth along which rocks on one side have moved relative to those on the other side. Most faults are the result of repeated displacements over a long period of time. Numerous active and potentially active faults have been mapped in the region.

The project area contains two types of faults: 1) those with surface expressions (traces) and, 2) buried or blind thrust faults. A fault trace (surface expression) is the line on the earth's surface, which defines the particular fault. Buried or blind thrust faults are thought to underlay much of the project area. These "buried" faults do not leave traces on the earth's surface as they are deep below. Although these faults typically do not offset surface deposits, they do generate co-seismic uplift and likely cause co-seismic movement on fault traces, which may be linked to the blind thrust at substantial depth.

Surface Rupture and Ground Shaking

Surface Rupture

Surface ruptures occur when movement on a fault deep within the earth breaks through to the surface. Rupture of the surface during earthquake events is generally limited to the narrow strip of land immediately adjacent to the fault on which the event is occurring.

Fault surface rupture almost always follows preexisting faults, which are zones of weakness. Rupture may occur suddenly during an earthquake, or slowly in the form of fault creep. Sudden displacements are more damaging to structures because they are accompanied by shaking.

Because the project area contains several active and potentially active faults, the potential to generate earthquake events is considered high. As a result, the likelihood of surface rupture in each of the counties of the project area is also considered high.

Ground Shaking

Earthquake-induced ground shaking can pose threats to people and structures even at distant locations from the fault on which the earthquake event is occurring. Ground shaking at a particular location depends on the earthquake magnitude (e.g., a measure of total energy released by fault rupture); epicentral distance (e.g., the distance from the center of the fault rupture to the location of interest); and, subsurface conditions of the geologic and soil units at the location of interest.

Seismically-Induced Landslides

Strong ground shaking during earthquake events can generate landslides and slumps in uplands or coastal regions in the vicinity of the fault on which the earthquake is occurring. The zone of opportunity for seismically-induced landsliding is about 75 miles for a magnitude 6.5 earthquake.

Seismically-induced landslides would be most likely to occur in areas that have previously experienced landslides or slumps, in areas of steep; slopes, or in saturated areas. Portions of the project area would be susceptible to seismically-induced landsliding because of the abundance of active faults in the region and the existing landslide hazards.

REGULATIONS, APPROVALS, AND PERMITS APPLICABLE TO GEOLOGY AND SOILS

STATE

California Building Code

The *California Building Code* is another name for the body of regulations known as the California Code of Regulations (CCR), Title 24, Part 2, which is a portion of the California Building Standards Code (CBSC, 1995). Title 24 is assigned to the California Building Standards Commission, which, by law, is responsible for coordinating all building standards. Under state law, all building standards must be centralized in Title 24 or they are not enforceable (Bolt, 1988). Published by the International Conference of Building Officials, the Uniform Building Code (UBC) is a widely adopted model building code in the United States. The California Building Code incorporates by reference the Uniform Building Code with necessary California amendments. About one-third of the text within the California Building Code has been tailored for California earthquake conditions. Although widely accepted and implemented throughout the United States, local, city and county jurisdictions can adopt the UBC either in whole or in part.

Alquist-Priolo Special Study Zones

The Alquist-Priolo Earthquake Fault Zoning Act of 1971 requires that special geologic studies be conducted to locate and assess any active fault traces in and around known active fault areas prior to development of structures for human occupancy. This state law was a direct result of the 1971 San Fernando Earthquake, which was associated with extensive surface fault ruptures that damaged numerous homes, commercial buildings, and other structures.

The Alquist-Priolo Act’s main purpose is to prevent the construction of buildings used for human occupancy on the surface trace of active faults. This Act only addresses the hazard of surface fault rupture and is not directed toward other earthquake hazards. Surface rupture is the most easily avoided seismic hazard.

Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act of 1990 addresses non-surface fault rupture earthquake hazards, including liquefaction and seismically induced landslides. The purpose of the Act is to protect public safety from the effects of strong ground shaking, liquefaction, landslides, or other ground failure, and other hazards caused by earthquakes. The program and actions mandated by the Seismic Hazards Mapping Act closely resemble those of the Alquist-Priolo Earthquake Fault Zoning Act.

LOCAL CITY AND COUNTY

General Plans and Seismic Safety Element

Cities and county governments typically develop as part of the General Plans, safety and seismic elements that identify goals, objectives, and implementing actions to minimize the loss of life, property damage and disruption of goods and services from man-made and natural disasters including floods, fires, non-seismic geologic hazards and earthquakes. General Plans can provide policies and develop ordinances to ensure acceptable protection of people and structures from risks associated with these hazards. Ordinances can include those addressing unreinforced masonry construction, erosion or grading.

IMPACTS AND MITIGATION MEASURES

Issues (and Supporting Information Sources):	*Potentially Significant Impact*	*Less Than Significant with Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
GEOLOGY AND SOILS—Would the project:				
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.	☐	☐	☐	☒
ii) Strong seismic ground shaking?	☐	☐	☐	☒
iii) Seismic-related ground failure, including liquefaction?	☐	☐	☐	☒
iv) Landslides?	☐	☐	☐	☒
b) Result in substantial soil erosion or the loss of topsoil?	☐	☐	☒	☐
c) Be located on geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?	☐	☐	☒	☐
d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?	☐	☐	☒	☐
e) Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater?	☐	☐	☐	☒

APPROACH TO ANALYSIS

The impact assessment used a qualitative analysis to address soil resources, geologic hazards and primary and secondary effects of earthquakes. Geologic and seismic hazards that, because of the project, would expose people to injury and infrastructure to damage were considered in terms of an adverse impact to public safety. Loss of soil resources from erosion and sedimentation caused by the project were considered in terms of depletion or as having other adverse effects on soil resources. The proposed project elements were evaluated in terms of the level of significance and whether the impacts were considered not significant, less than significant or significant.

CRITERIA FOR DETERMINING SIGNIFICANCE

CEQA defines a significant effect on the environment as a substantial, or potentially substantial, adverse change in the physical conditions within the area affected by the project. The *CEQA Guidelines* lists several geology-related impacts that would normally be considered significant. These include exposing people or structures to major geologic hazards (expansive soils, landslides) and seismic hazards (fault rupture, groundshaking, liquefaction); substantial erosion or siltation; causing substantial changes in topography; adversely affecting unique geologic or topographic features; or inundation due to dam failure, seiche, or tsunami. The analysis of significance of impacts on geology and soils is based on professional judgment and on criteria VI.a–e in the environmental checklist.

IMPACT MECHANISMS

Geology, seismicity, and soil impact mechanisms include damage to SCG/SDG&E infrastructure by seismic events, static soil movement and erosion. Groundshaking from seismic events can cause secondary hazards such as surface fault rupture, liquefaction and settlement of soils. Settlement can also occur in improperly placed artificial fills and compressible soils when subject to static loads. Initiation of shallow landslides and accelerated erosion can be caused by soil disturbance during the installation of the cable and other system facilities. However, proposed engineering practices include designing a system that minimizes geologic hazards or seismic risk to reduce potential damage to SCG/SDG&E natural gas pipelines with FIG implementation or to the surrounding environment.

IMPACT ASSESSMENT

a. Would the project expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earthquake fault, strong seismic ground shaking, seismic-related ground failure (including liquefaction), or landslides?

The proposed project includes the implementation of a technology that places conduit within existing natural gas pipelines. The utility structure would already be in place prior to FIG installation, and because the conduit would be placed inside the natural gas pipeline, the new structure would not be exposed to many of the geologic hazards presented in this section. Ground surface rupture and displacement of active or potentially active fault traces could potentially damage the conduit structure where the natural gas pipelines pass through faults. Damage from earthquake activity could temporarily disrupt cable network operation and result in periods of interrupted service while the system is inspected and repaired. The implementation of FIG technology in natural gas pipelines would not increase the human or environment exposure to the impact of surface fault rupture across active traces of earthquake faults. Therefore, no impact relating to surface fault rupture from the project would occur.

The project area will likely experience at least one major earthquake (greater than moment magnitude 7) within the next 30 years. The intensity of such an event will depend on the causative fault and the distance to the epicenter, the moment magnitude and the duration of shaking. Damage due to groundshaking could disturb or cause breakage of cable conduit. Given the unobtrusiveness of the installed conduit and the absence of surface structure, any damage will not affect humans or the environment. Seismic groundshaking would not result in an impact because the proposed project would not increase the amount of people exposed to potential adverse effects of groundshaking or increase the severity of the groundshaking in the project area.

Additionally, the project area includes regions that are subject to earthquake-induced liquefaction. Liquefaction and resulting differential ground settlement and lateral spreading could damage the conduit system. If damage from liquefaction failures were to occur, it could temporarily disrupt cable network operation and result in periods of interrupted service while the system is inspected and repaired. The project would not increase the human or environment exposure to liquefaction of other seismic ground failure, therefore, the no impact from groundshaking would occur.

b. Would the project result in substantial soil erosion or the loss of topsoil?

Impact GEO-1: Initial construction operations and periodic repairs for the project could result in temporary accelerated erosion and sedimentation from soil disturbance and/or vegetation removal.

Soils throughout the project area, many of which are already disturbed, vary widely with respect to their erosion hazard. Ground-disturbing activities, including removal of vegetation, can cause increased water runoff rates and concentrated flows and may cause accelerated erosion, with a consequent loss of soil productivity. Because the area of soil disturbance will be small within a given area, there will not be a significant opportunity for erosion to occur. This impact is considered less than significant.

Mitigation Measure: No mitigation required.

c. Would the project be located on strata or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?

Impact GEO-2: The FIG project area could be subjected to geologic hazards including settlement, and slope failure.

The susceptibility of land (slope) failure is dependent on the slope and geology, as well as the amount of rainfall, excavation or seismic activities. Areas most susceptible to landsliding are characterized by steep slopes and include most existing landslides with substantial evidence of down-slope creep of surface materials. Landslides are least susceptible in areas that are topographically low alluvial fans.

The general developed environments in the project area where FIG technology would be implemented would consist of gently sloping and stable terrain within existing roads and road shoulders where existing natural gas pipelines are generally located in urban environments. Typically, applicable geotechnical engineering remedies were previously incorporated into the roadway and pipeline design to reduce the likelihood of soil failure. Additionally, FIG technologies involve placement of conduit within existing pipeline infrastructure and would not require installation excavation into steep slopes, particularly those subject to mass movement (i.e., landsliding, debris flows). The proposed project itself would not increase the potential for slope failures and would not result in exposing people, property or the environment to additional slope stability hazards or result in an adverse physical effect on humans or the environment. Therefore, this impact is considered less than significant.

Mitigation Measure: No mitigation required.

d. Would the project be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code, creating substantial risks to life or property?

Impact GEO-3: The FIG project area could be subjected to geologic hazards relating to expansive soils.

Parts of the project area contain soils that are considered expansive by the Uniform Building Code and by the U.S. Natural Resources Conservation Service. The effects of expansive soils could damage foundation of aboveground structures, paved roads and streets, and concrete slabs. FIG technologies involve installation of conduit within existing pipeline infrastructure. Structural damage to the conduit system could potentially result where conduit is installed in a pipeline system placed in expansive soils. However, insertion of the conduit into the pipeline would not affect the stability of the pipeline or increase the risk of structural damage to the existing pipe. Additionally, an impact from expansive soils would not occur because any damage that could occur would not have an adverse physical effect on humans or the environment.

Mitigation Measure: No mitigation required.

e. Would the project have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater?

No septic tanks or alternative wastewater disposal systems will be installed as part of the proposed project. No impacts will occur.